10/579201
IAP9 Rec'd PCT/PTO 12 MAY 2006

Injection Element

The invention relates to an injection element, in particular for a rocket drive, according to the preambles of claims 1 and 6.

Injection elements are used in a rocket drive for the mixture preparation and for ensuring an optimal combustion in a combustion space of the rocket drive.

An injection element in coaxial construction for operation with two hypergolically reacting fuels is known, e.g., from DE 43 05 154 C1. With this injection element, the combustion fuel flow fed separately to the combustion chamber is divided by means of a flow divider provided with bores, into several individual flows distributed over the circumference of the feed channel. This is to render possible a stable combustion without relevant pressure fluctuations.

Furthermore, an injection element is known from DE 101 30 355 A1 in which a fuel flow fed to a combustion chamber is divided and the two partial flows thus produced are injected into the combustion chamber in a separated manner. The injection hereby occurs in the form of two hollow cone flows coaxial to one another. An optimal droplet preparation with different droplet size in the two hollow cone flows can thus be achieved, which render possible special combustion zones with different combustion behavior or a gradual combustion of the fuel.

DE 195 15 879 C1 describes an injection element in bicoaxial construction, i.e., the injection element comprises an inner element with a first outlet opening to form a conical oxidant jet and an outer element arranged coaxially thereto with further second outlet openings in the form of passage channels to form fuel jets.

In many cases it is necessary to create a zone for cooling an area of the combustion chamber close to the wall. In order to achieve this, in part the integration is resorted to of additional injection elements embodied especially for this purpose. These can be on the one hand elements with liquid swirl and on the other hand also simple elements with bores.

The object of the present invention is now to create an injection element, in particular for a rocket drive, which at the same time renders possible the formation of a cooling liquid film layer for the injection of fuel in a combustion space.

This object is attained through an injection element with the features of claim 1 or 6. Preferred embodiments of the injection element are shown by the dependent claims.

One important concept of the invention lies in providing bores in an inner or an outer element of the injection element, which bores are used to separate the fuel necessary for a cooling liquid film layer. The advantage of such an injection element is that elements already present of conventional injection elements are used to create a fuel-rich or oxidizer-rich zone. Furthermore, only one element is required to form a cooling film area, additional elements are not necessary. In addition, there is the possibility of creating two zones in the combustion space with the injection element according to the invention. Furthermore, a gradual reaction (combustion) can be achieved with the invention. Finally, the invention is suitable for use in a wide operating range with regard to a mixing ratio of fuel.

The invention now relates to an injection element, in particular for a rocket drive, with an inner element with a first outlet opening and an outer element arranged coaxially thereto with at least one second outlet opening arranged coaxially to the first outlet opening for receiving and injecting fuel in a combustion space. According to the invention, the outer element has in addition third outlet openings in the form of bores for forming a cooling liquid film layer, which bores are arranged coaxially to the first and second outlet openings.

In particular, the outer element can have a swirler space for impressing a swirl in the fed fuel flow, in which the bores are provided. In this case, fuel for forming the cooling liquid film layer is split off via the bores in the swirler space. Swirlers are known, e.g., from DE 101 30 355 A1 already mentioned at the outset and are also referred to there as a swirl insert.

Preferably the bores are provided in a tapering area of the swirler space. The bores can thus receive fuel particularly efficiently.

The bores can be arranged in the outer element such that the influence of the cooling liquid film layer formed through the bores on the fuel injecting into the combustion space is as slight as possible. In other words, the bores can be aligned such that the cooling liquid film layer and the fuel injecting into the combustion space just after entry into the combustion space do not touch one another or mix.

The bores can change over into an annular gap to generate a swirl. In this case a cooling liquid film layer is formed with a swirl, which can have an advantageous effect on the formation of an optimal mixture in the combustion space.

The invention further relates to an injection element, in particular for a rocket drive, with an inner element with a first outlet opening and an outer element arranged coaxially thereto with at least one second outlet opening arranged coaxially to the first outlet opening for receiving and injecting fuel into a combustion space, in which according to the invention the inner element has third outlet openings in the form of bores for forming a cooling liquid film layer, which bores are arranged coaxially to the first and second outlet openings.

With this type of injection element, a partial premixing takes place that is of major importance for an optimal combustion, particularly in the case of elements with hollow cones of injected fuel that do not overlap.

With the two types of injection elements explained above according to the invention the bores can be distributed in particularly uniformly over the entire circumference of the outer or of the inner element. A conical cooling liquid film is thus created. This is expedient in particular with drives with only one injection element (single-element chambers). With such drives the conical liquid film then serves to cool the inner wall of the combustion space and avoids an enrichment of excess fuel during the phase of the ignition in the area of the combustion space close to the wall. This is very important, particularly with short-term operations, and greatly reduces the danger of the deposit of too much residue

such as, e.g., soot on the inner wall of the combustion chamber. As already mentioned, a two-zone combustion can be created above all by means of only one injection element.

In particular when several injection elements are used, it is more advantageous if the bores are distributed in particular uniformly over only a part of the circumference of the outer or inner element. Preferably the bores should then be arranged in the part of the circumference that lies adjacent to the inner wall of the combustion space so that the liquid film layer exiting from the bores sprays in the direction of the inner wall.

With a preferred embodiment with simple bores for feeding a component, the bores are preferably aligned such that fuel jets exiting from them are mixed with the component jets leaving the components feed bores. A premixing of fuel and component thus occurs through which a droplet formation already takes place early. This has an advantageous effect in the main mixing with a hollow cone of a swirler element.

Finally the invention relates to the use in a rocket engine that has a combustion space. The rocket engine is characterized in that it has at least one injection element according to the invention.

In particular the at least one injection element according to the invention is arranged with the rocket engine such that the cooling liquid film layer exiting from it is directed at least in part towards the combustion space inner wall.

Further advantages and application possibilities of the present invention are revealed by the following description in connection with the exemplary embodiments shown in the drawings.

The terms used in the list of reference numbers at the end and the reference numbers assigned thereto are used in the specification, in the claims, in the abstract and in the drawings. The drawings show:

Fig. 1A A first exemplary embodiment of an injection element according to the invention in cross section;

Fig. 1B A second exemplary embodiment of an injection element according to the invention in cross section;

Fig. 2A A third exemplary embodiment of an injection element according to the invention in perspective cross section;

Fig. 2B A fourth exemplary embodiment of an injection element according to the invention in perspective cross section;

Fig. 2C The front face of the injection element shown in Fig. 2A in plan view;

Fig. 2D The front face of the injection element shown in Fig. 2B in plan view;

Fig. 3 An arrangement of several injection elements in the combustion space of a rocket engine;

Fig. 4 A fifth exemplary embodiment of an injection element according to the invention in cross section;

Fig. 5 A sixth exemplary embodiment of an injection element according to the invention in perspective cross section; and

Fig. 6 A seventh exemplary embodiment of an injection element according to the invention in perspective cross section.

The same and functionally the same elements can be provided with the same reference numbers below.

Fig. 1A shows in cross-sectional representation an injection element 10 with an inner element 12 and an outer element 14. Inner and outer element 12 or 14 are arranged coaxially to one another. Both elements receive fuel under high pressure, which fuel is injected through each element respectively in the form of a hollow cone into a combustion space (not shown) of a rocket drive. The fuel is injected via feed bores 60 and 62 into the inner or outer element 12 or 14. Moreover, the outer element 14 has a swirler space 18 in order to give the fuel a swirl.

Fig. 2A shows the injection element 10 from Fig. 1A in a perspective cross-sectional representation. Here the front face 30 of the injection element 10 can be seen clearly from which the fuel exits and is injected into the combustion space.

The outer element 14 has several bores 16 in its outer wall 28, which bores begin in the tapering area 20 of the swirler space 18 and end in the front face 30 facing the combustion space. The bores 16 receive the fuel located in the swirler space 18 and feed the received fuel to the combustion space in the form of another hollow cone. The bores 16 are aligned such that the fuel sprays into the combustion space in the form of a hollow cone that opens in the direction of the inner wall of the combustion space in order to cool the inner wall.

Fig. 1B shows another injection element 11 in cross section, which element is essentially similar to the injection element 10 of Fig. 1A, in which, however, inclined bores 24 are provided in the outer element 15, which bores end in an annular gap 22 of the outer element 15. With this exemplary embodiment the fuel is injected via the annular gap 22 with a swirl into the combustion space. To this end the bores 24 are inclined in two levels. Fig. 2A shows this exemplary embodiment in a perspective cross-sectional view. Through the inclination of the bores 24, the fuel is already injected into the annular gap 22 with a swirl.

Figs. 2C and 2D show the front faces 30 and 32 of the two exemplary embodiments of the injection elements 10 or 11 shown in Figs. 1A, 2A or 1B, 2B. With the first exemplary embodiment 10 in Fig. 2C a total of eight bores 16 are uniformly distributed over the circumference of the front face 30, i.e., the bores 16 are equally distanced from one another. With the second exemplary embodiment 11 in Fig. 2D four bores 16 distributed uniformly over the circumference of the front face 32 discharge into the annular gap 22. Both injection elements 10 and 11 are suitable as single elements for a combustion space or a combustion chamber.

Fig. 3 shows the arrangement of several injection elements 28 and 34 in a combustion chamber of a rocket engine. The injection elements labeled 34 are

conventional injection elements that serve only to inject fuel into the combustion space. Although the injection elements 28 according to the invention likewise serve to inject fuel, at the same time they serve to form a liquid film layer cooling the combustion space inner wall 26. They differ from the exemplary embodiments 10 and 11 explained above in that bores 16 are provided only on the part of the circumference of the front face of these injection elements 28 that is arranged directly adjacent to the combustion space inner wall 26, i.e., in the area of the circumference of the front face close to the wall. Fuel is thus sprayed from the bores 16 in the direction of the combustion space inner wall in order to cool it. This exemplary embodiment is suitable for engines with several injection elements as shown. Inhomogeneities can be influenced or correspondingly oriented through a corresponding remaining run length of the swirler space.

Fig. 4 shows in cross section another exemplary embodiment of an injection element 36 that has an inner element 38 and an outer element 40 arranged coaxially thereto. In this exemplary embodiment bores 42 are provided in the inner element 38, which bores end at the front face 43. The bores 42 are aligned such that the fuel thus split off from the inner element 38 mixes with the fuel injected into the combustion space through the outer element 40 (fuel hollow cone 46). Through this a partial premixing takes place which has an advantageous effect in particular with elements that form non-overlapping fuel hollow cones 44 and 46 as in the exemplary embodiment shown.

Figs. 5 and 6 finally show injection elements 48 and 50 that are provided with component feeds, more precisely with bores 52 or 54 for feeding a component. Fig. 5 shows an "unlike triplet" in which three liquid jets intersect (at reference number 56). In contrast Fig. 6 shows an "unlike doublet" in which two liquid jets intersect (at reference number 58). Through the "intersection" of the jets a pre-mixing occurs and thus a droplet formation, which has a favorable effect on the main mixing with the hollow cone of the swirler element.

List of Reference Numbers

10	Injection element
11	Injection element
12	Inner element
14	Outer element
15	Outer element
16	Bore
18	Swirler space
20	Tapering area of the swirler space 18
22	Annular gap
24	Inclined bore
26	Combustion space inner wall
28	Injection element
30	Front face of the injection element 10
32	Front face of the injection element 11
34	Injection element
36	Injection element
38	Inner element
40	Outer element
42	Bores
44	Inner fuel hollow cone
46	Outer fuel hollow cone
48	Injection element
50	Injection element

52	Bores for feeding a component
54	Bores for feeding a component
56	Intersection of three liquid jets
58	Intersection of two liquid jets
60	Feed bore for fuel
62	Feed bore for fuel